

DISK AND GLOBAL SERVICES

3-FEBRUARY, 2000

MECHANICS, SERVICES

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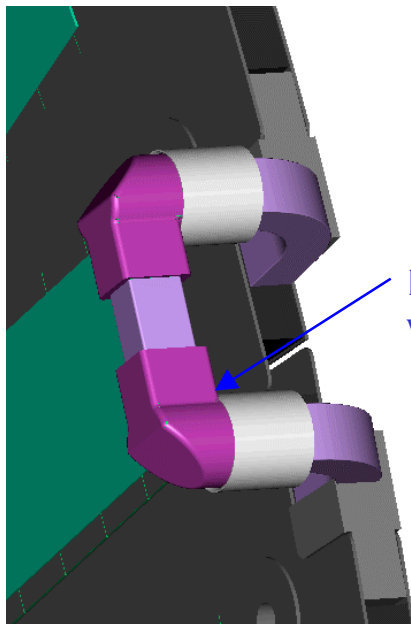
OVERVIEW

- **DEVELOP COOLING TUBE TERMINATION TO SECTOR**
 - ITERATED ABOUT DESIGNS WITH AIM TO REDUCE PRESSURE DROPS IN SECTOR U-TUBE
- **RESERVE SPACE FOR CONNECTION OF ELECTRICAL SERVICES TO SECTOR**
 - PIGTAIL DESIGN DELAYED IN PREFERENCE TO GETTING FULL EVAPORATIVE AND MONOPHASE LAYOUTS
- **REVERSE FIRST DISK**
 - CHOSE TERMINATIONS WHICH ALLOWED FIRST DISK TO REVERSE RELATIVELY PAINLESSLY
- **ROUTE DISK SERVICES AND BARREL SERVICES TO END OF FRAME**
 - PROPOSE, AND TRIED TO IMPOSE RULES ON ROUTING
- **MINI- AND FULL MODEL OF FRAME PENETRATION**
 - USED TO VERIFY PACKING FACTOR, BEND RADII, AND ESTIMATE FORCES
- **CABLE UPDATE**
 - SOME PROTOTYPES AVAILABLE

PIXEL DETECTOR

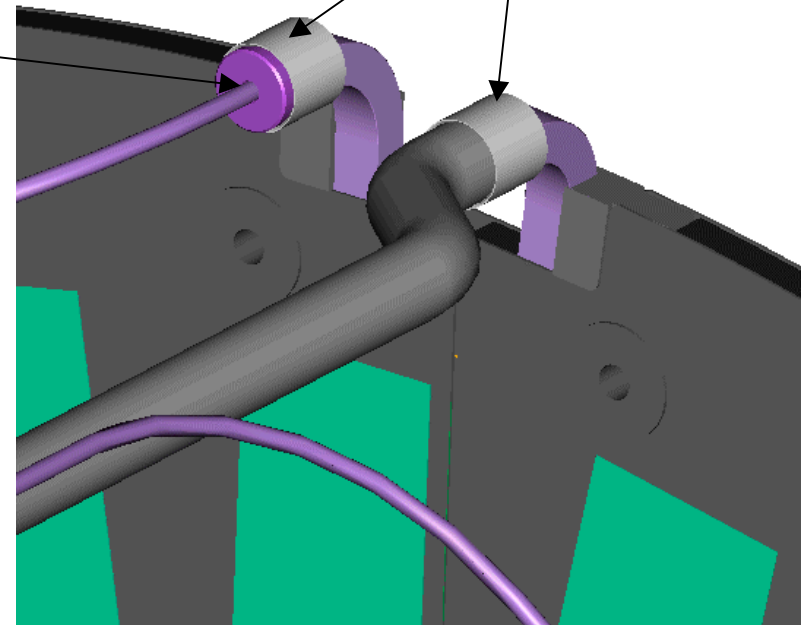
SERVICE TERMINATION

- **MINIMIZE PRESSURE DROP**
 - INVESTIGATED SEVERAL OPTIONS—FINAL CHOICE FIT BEST IN LAYOUT
- **SECTORS WILL BE TESTED WITH MONOPHASE SYSTEM FOR THERMAL COUPLING**
 - NEEDS TO BE COMPATIBLE WITH BOTH UNTIL SECTOR IS INSTALLED
- **TUBING WILL BE GLUED TO SECTOR**
 - MINIMIZE NUMBER OF JOINTS
 - MAKE LONG ENOUGH TO SERVICE/REPAIR



MAINTAINS CROSS-SECTION
WITHOUT MITER BEND

BONDED IN AT
DISK ASSEMBLY



O.D. CAN BE USED
IN TEST FITTING
FOR MONOPHASE
TESTING

PIXEL DETECTOR

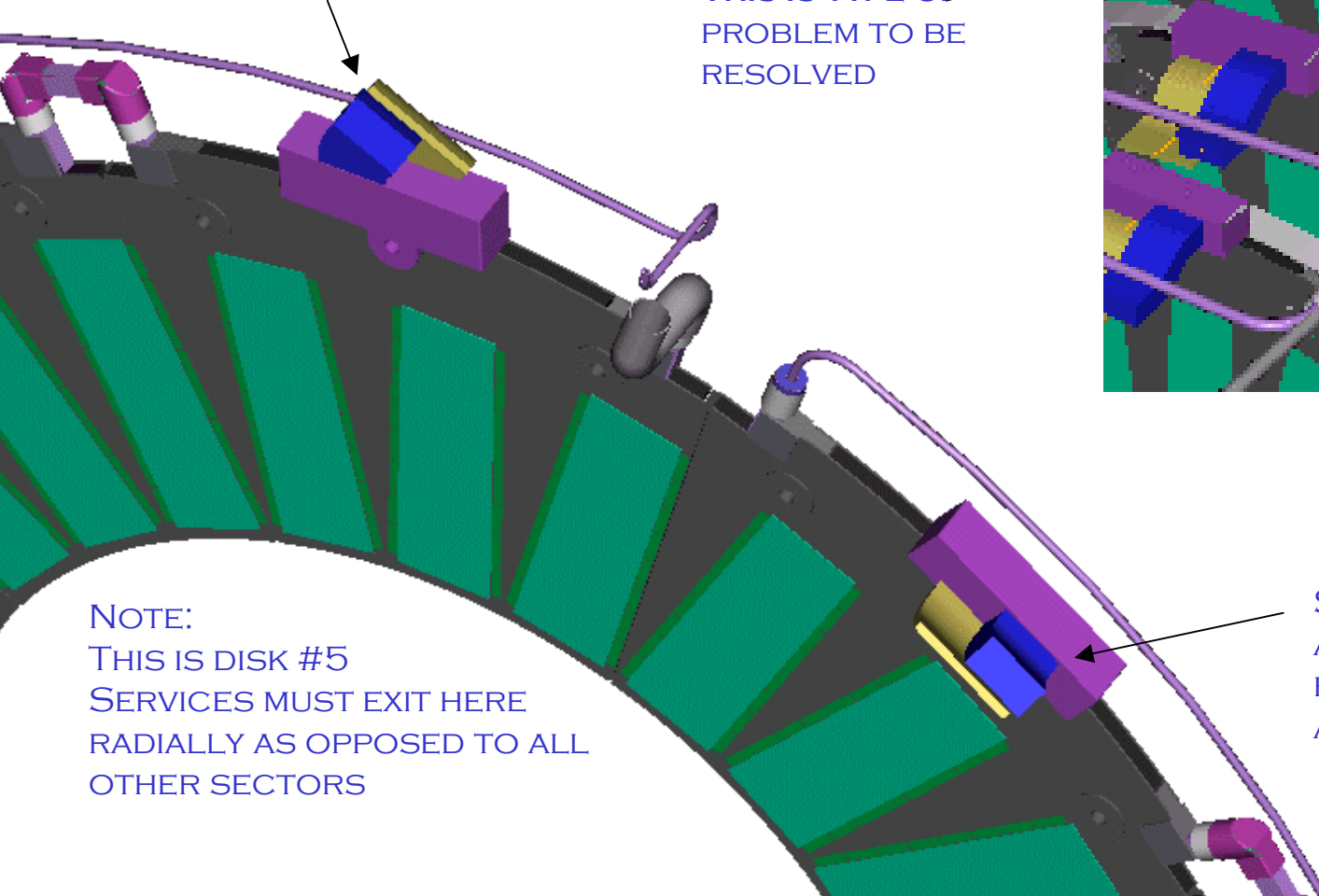
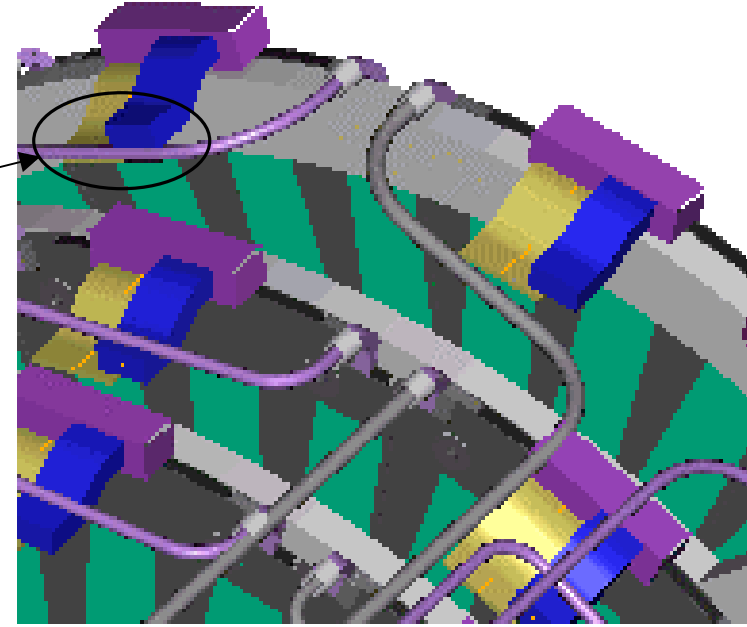
CABLE TERMINATION

ROUTING TO PASS BY
MOUNTING EAR OF END
PLATE STIFFENER

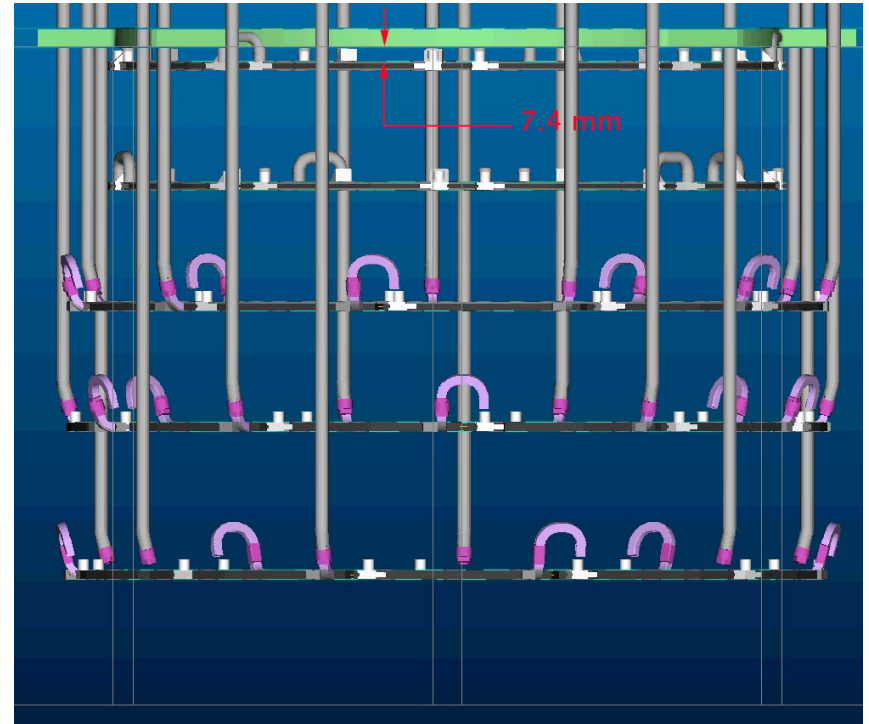
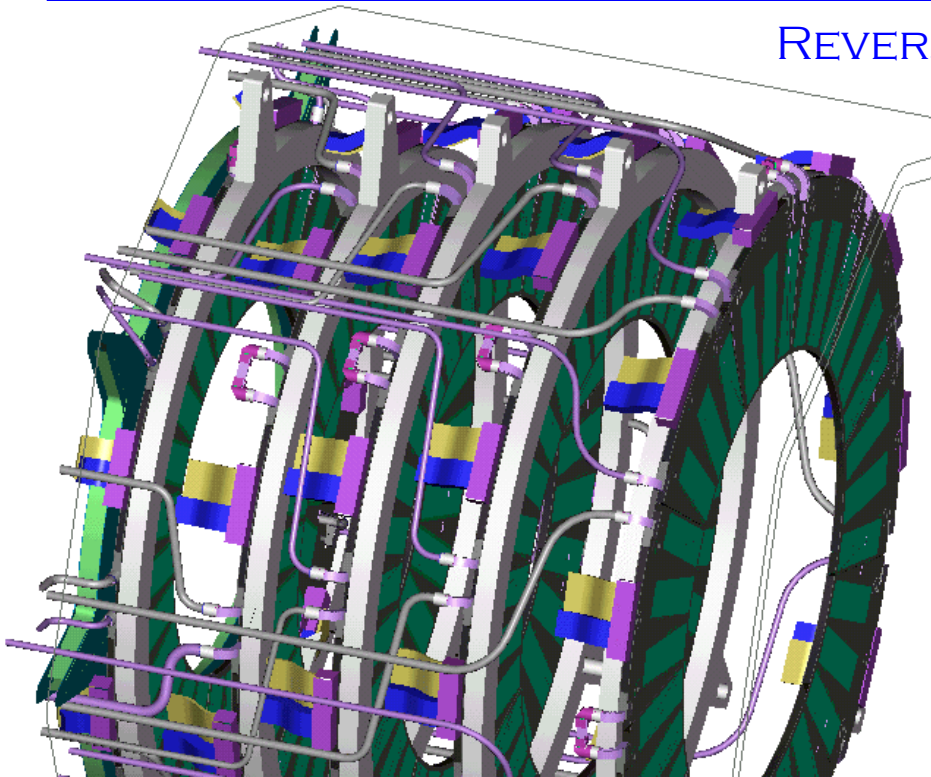
THIS IS TYPE OF
PROBLEM TO BE
RESOLVED

NOTE:
THIS IS DISK #5
SERVICES MUST EXIT HERE
RADIALLY AS OPPOSED TO ALL
OTHER SECTORS

SIMPLE BLOCK RESERVED
AT TOP OF EVERY SECTOR
EQUAL TO SUM OF WIDTHS
AND HEIGHTS OF CABLES



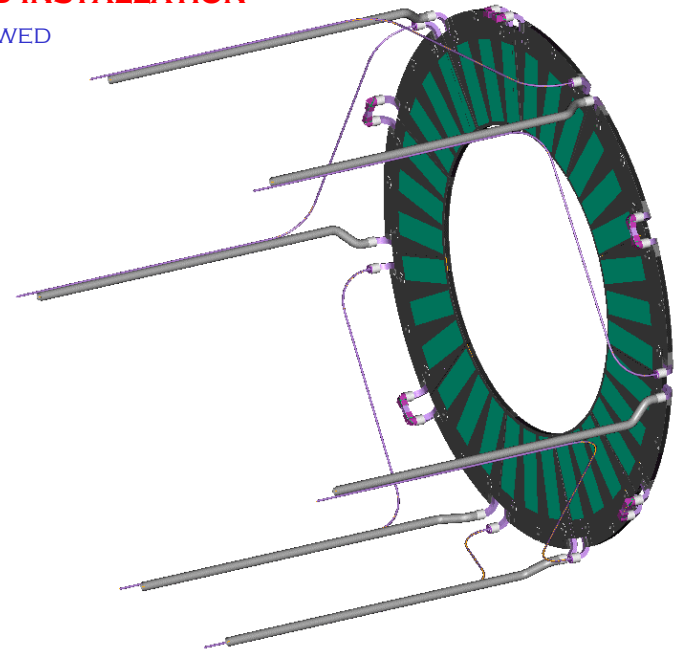
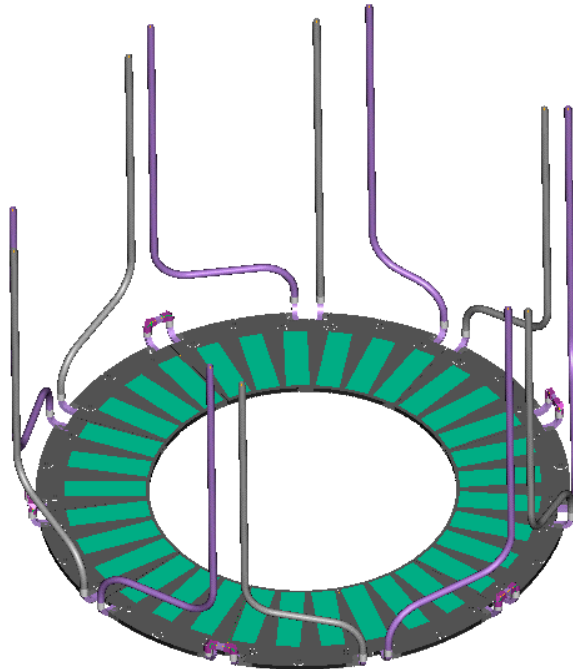
REVERSE DISK 1



- **DISK 1 HAS BEEN REVERSED (SUPPORT RING ON OTHER SIDE)**
- **GIVES MORE ROOM FOR BARREL SERVICE EXIT AND TERMINATION**
- **USES COMMON SECTOR DESIGN**
- **SOME PROBLEMS**
 - CABLE TERMINATION ON FIRST DISK
 - SLIGHT ASYMMETRY TO MOUNTING (ACCURATE FACE OF SECTOR)

TUBE DESIGN PHILOSOPHY

- **LOOK TO MAKE ALL TUBES 2D BENT SHAPES**
- **BUILD SUFFICIENT COMPLEXITY INTO MODELS FROM START TO ALLOW ADJUSTMENT**
 - EACH TUBE IS DOG-LEGGED AND HAS ADJUSTMENT IN ALL DEGREES OF FREEDOM
 - STARTED WITH TUBING SETS-ENDED WITH CUSTOM TUBES FOR EACH CIRCUIT
 - MOST CABLES ARE STILL THE SAME-DISK 5 EXCEPTED
- **MONOPHASE AND EVAPORATIVE HAVE DIVERGING ROUTING PHILOSOPHIES**
 - EVAPORATIVE WANTS TO GROUP SUPPLY AND RETURN TOGETHER FOR A GIVEN CIRCUIT
 - MONOPHASE WANTS SUPPLIES AND RETURNS GROUPED IN BUNDLES (OPPOSITE)
- **COMMON RULES I'VE IMPOSED TO EASE INTEGRATION AND INSTALLATION**
 - NO PENETRATION OR TRAPPING OF SUPPORT ELEMENTS IS ALLOWED
 - SPECIFIED MIN BEND RADII FOR TUBES AND CABLES
 - COOLING CIRCUITS ENTER AND LEAVE THE SAME FRAME OCTANT
 - EQUAL NUMBER OF CIRCUITS PER OCTANT

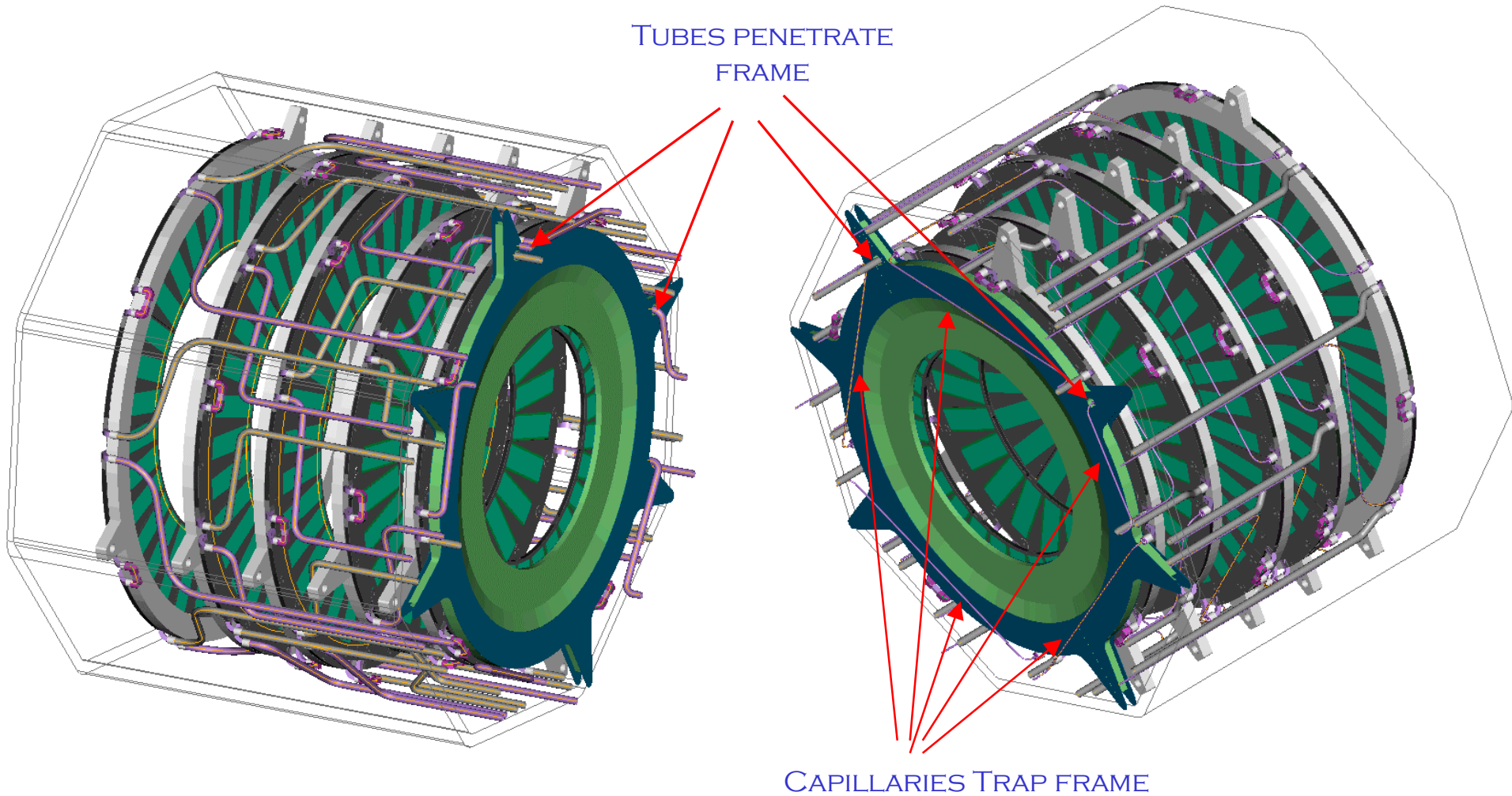


MONOPHASE V.S. EVAPORATIVE INITIAL COMMENT

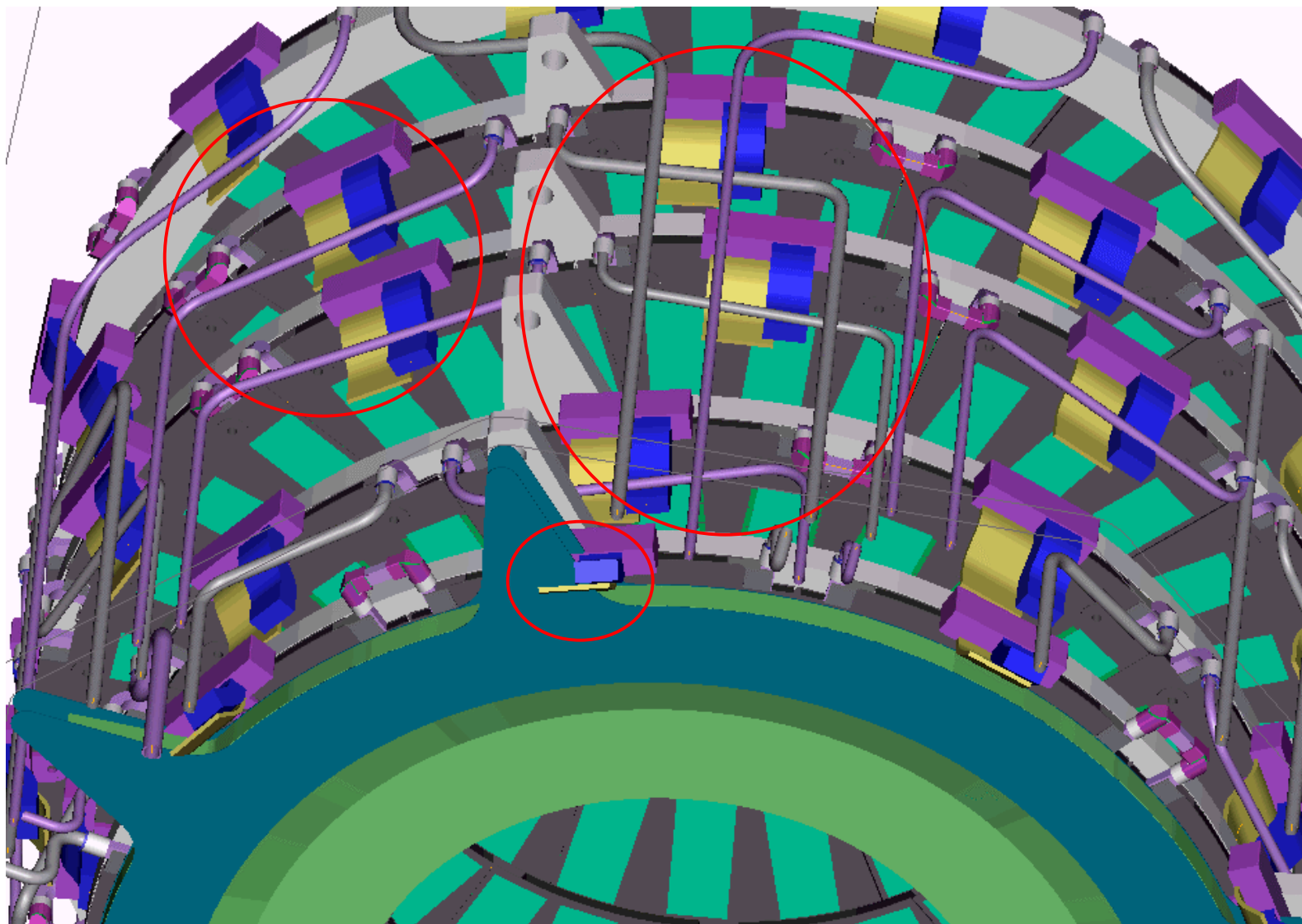
- **EVAPORATIVE LAYOUT IS VERY CLEAN**
 - CAPILLARIES ALLOW FOR EASY ROUTING
 - OVERALL TUBE LENGTH IS SHORTER DUE TO EASIER ROUTING OF EXHAUST
 - HAVEN'T PUT CABLES INTO EVAPORATIVE MODEL YET
- **MONOPHASE IS CROWDED, BUT FEASIBLE**
 - SAME OCTANT RULE CONTRIBUTES TO LONGER TUBE LENGTHS
 - TUBING IS HARDER TO ROUTE OUT
 - MANY OBVIOUS INTERFERENCES WITH CABLE VOLUMES, BUT MAYBE SAME IN EVAPORATIVE
- **EVAPORATIVE COOLING IS BASELINE DESIGN**
 - MONOPHASE MODEL STEMMED FROM EFFORT SPENT TO DEVELOP ROUTING FOR EVAPORATIVE COOLING
 - OPTIMIZATION FOR BOTH LAYOUTS STILL NEEDS TO BE ADVANCED SIGNIFICANTLY
- **CABLES NEED TO BE ADDED TO BOTH MODELS**
 - CURSORY INSPECTION INDICATES THAT NEITHER SOLUTION MAKES IT EASY FOR THE CABLES CURRENTLY
 - PIGTAIL SHOULD BE DEVELOPED WHICH BALANCES WELL WITH TUBING CONSTRAINTS
 - WILL DEVELOP TUBING FURTHER PRIOR TO PIGTAIL DESIGN

PIXEL DETECTOR

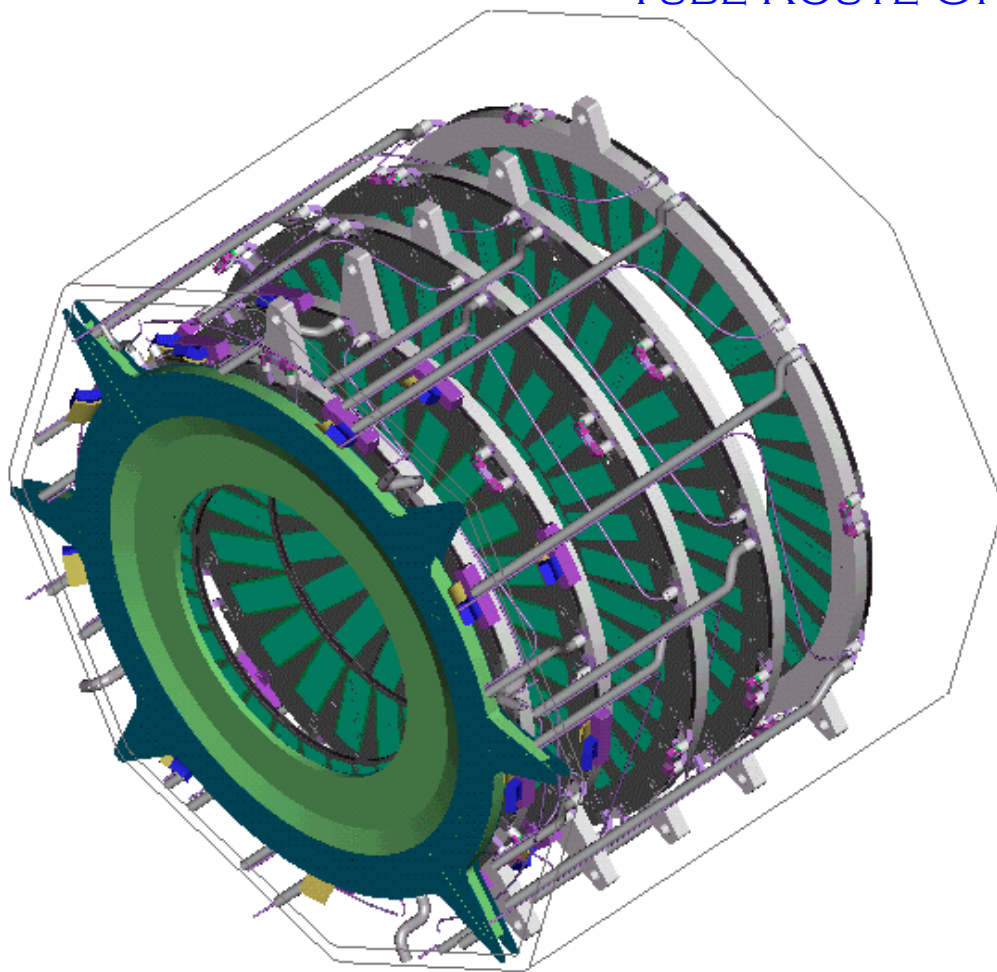
TUBE ROUTE BASELINES



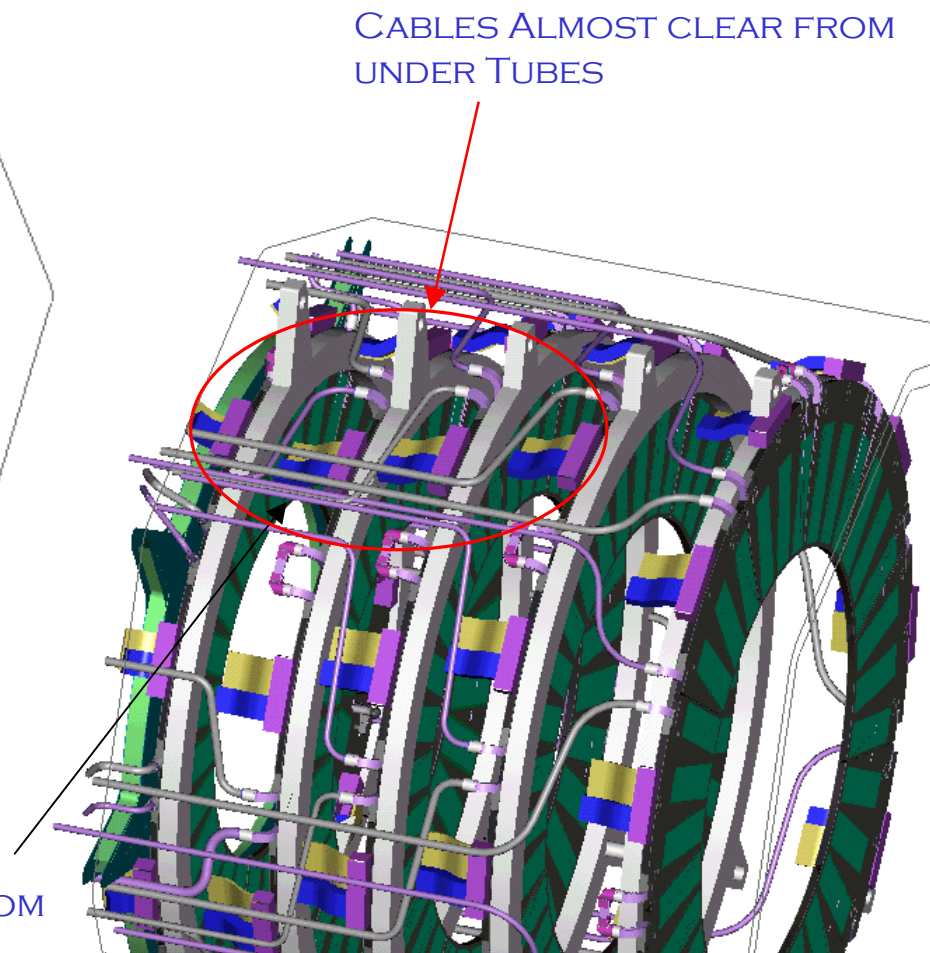
CABLES ADDED



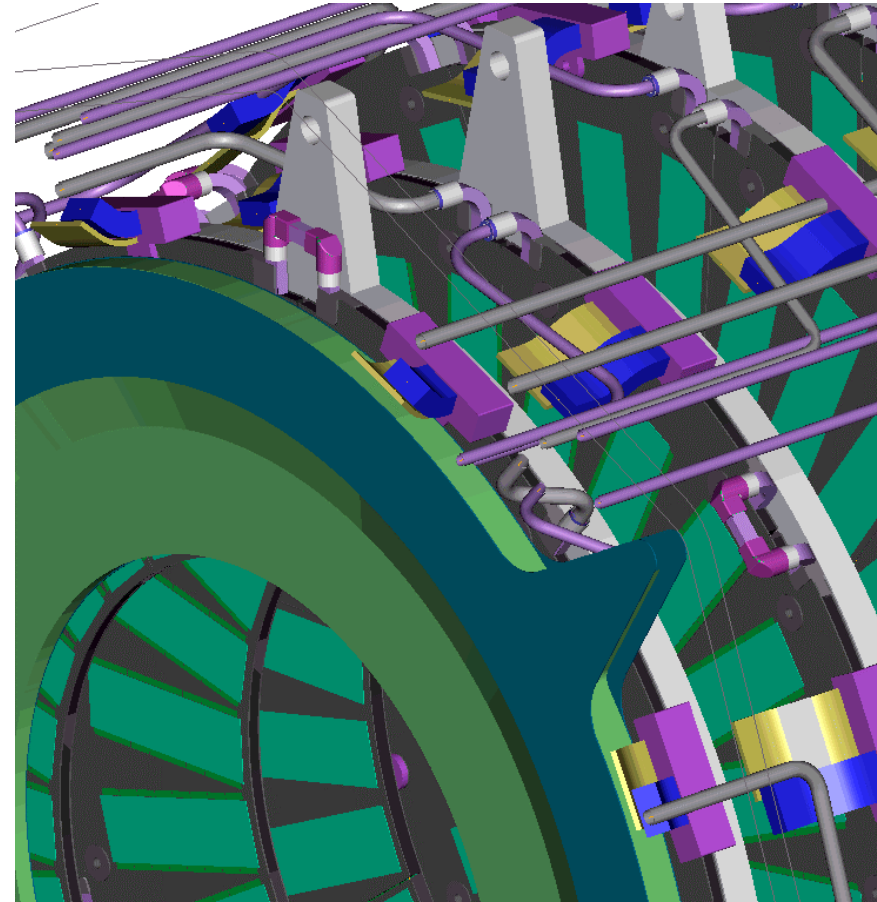
TUBE ROUTE OPTIMIZATION



BEGINNING TO HARMONIZE TUBES FROM
DISK TO DISK



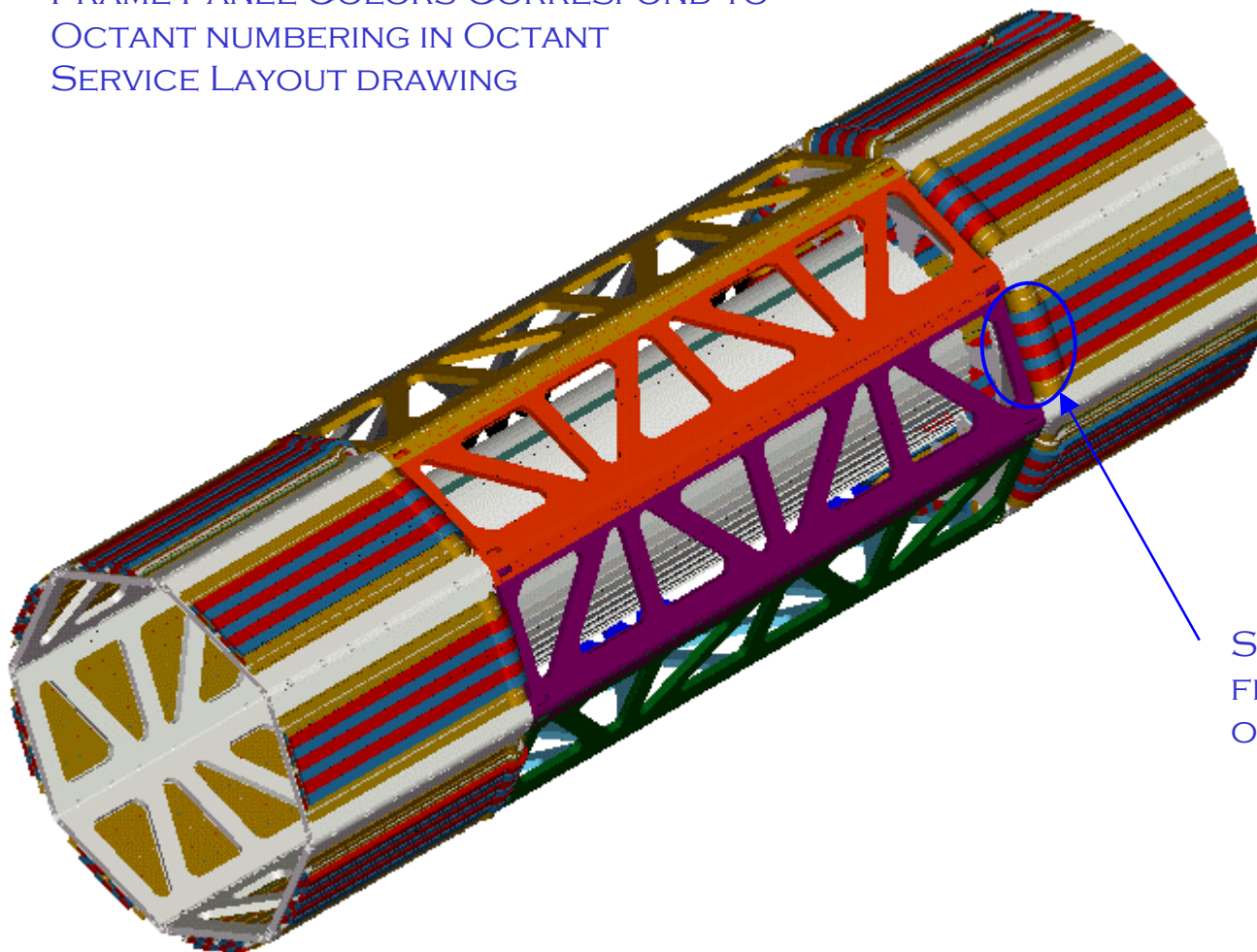
- **NEED TO HAVE ALL SERVICES ROUTED TO END OF FRAME TO INTEGRATE WITH END-PLATE STIFFENER**
 - TUBES WILL NEED FITTINGS FOR INSTALLATION PURPOSES
 - ALL SERVICES WILL BE STRAIN RELIEVED AT THIS POINT BY THE END-PLATE
- **ROOM IS EXTREMELY TIGHT IN THIS AREA-ENVELOPES ESTABLISHED FOR ASSEMBLY REASONS**
 - SERVICES HAVE 15MM TO MAKE BEND AT END OF FRAME (Z-ENVELOPE 798 (-3))
 - R-ENVELOPE IS 254MM
 - NEED TO FINISH LAYOUT PRONTO TO FIGURE IF ENVELOPES ARE SUFFICIENT



BARREL SERVICES

FRAME PANEL COLORS CORRESPOND TO
OCTANT NUMBERING IN OCTANT
SERVICE LAYOUT DRAWING

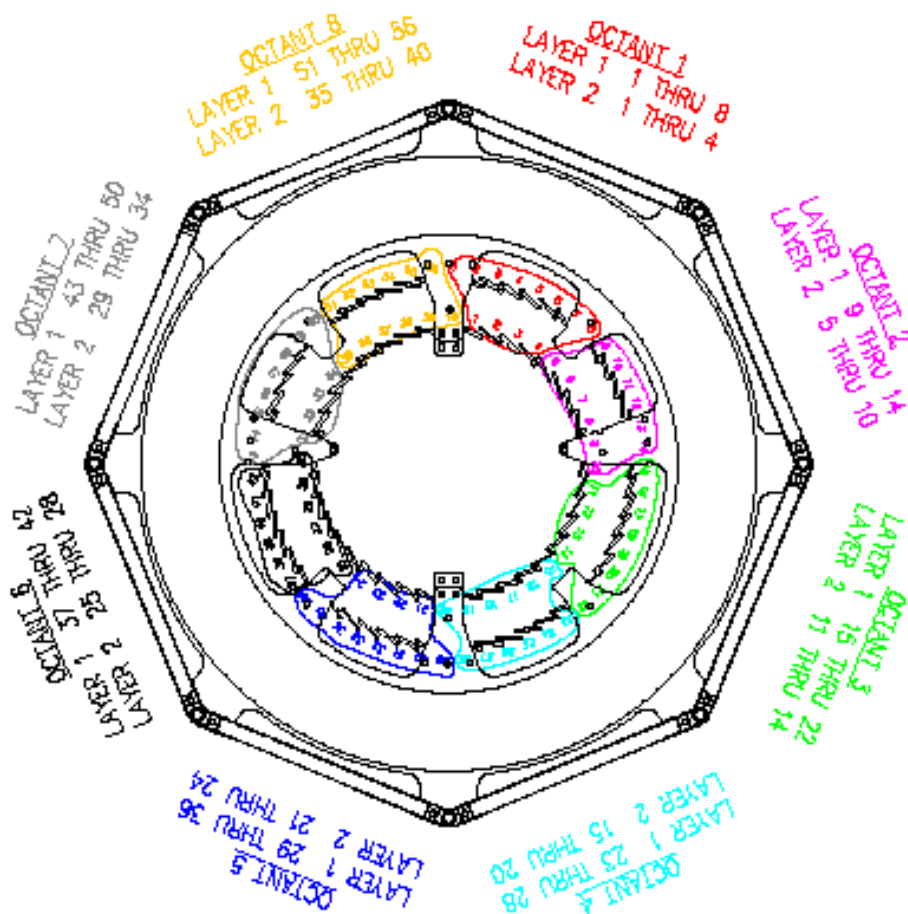
BUNDLES DEFINED FOR
BOTH EVAPORATIVE AND
MONOPHASE



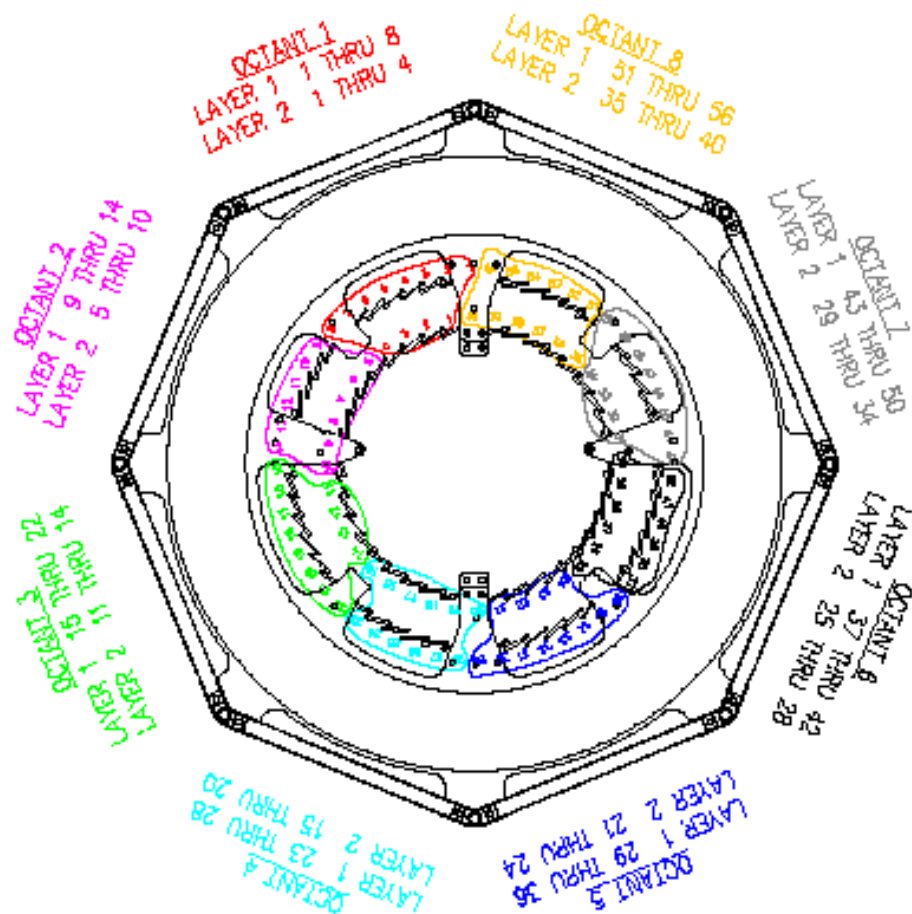
SERVICE BUNDLES PENETRATE
FRAME AND PROCEED TO END
OF FRAME

OCTANT LAYOUT

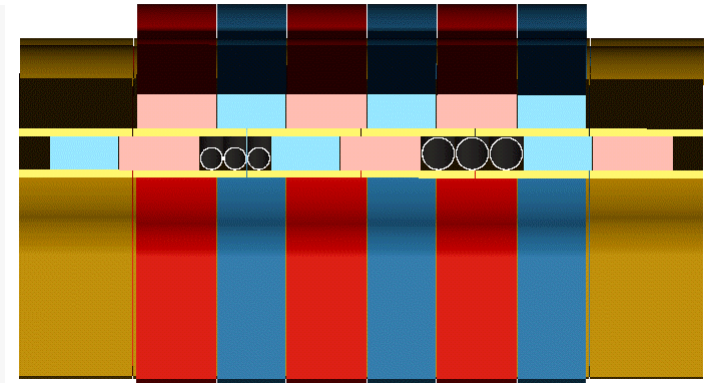
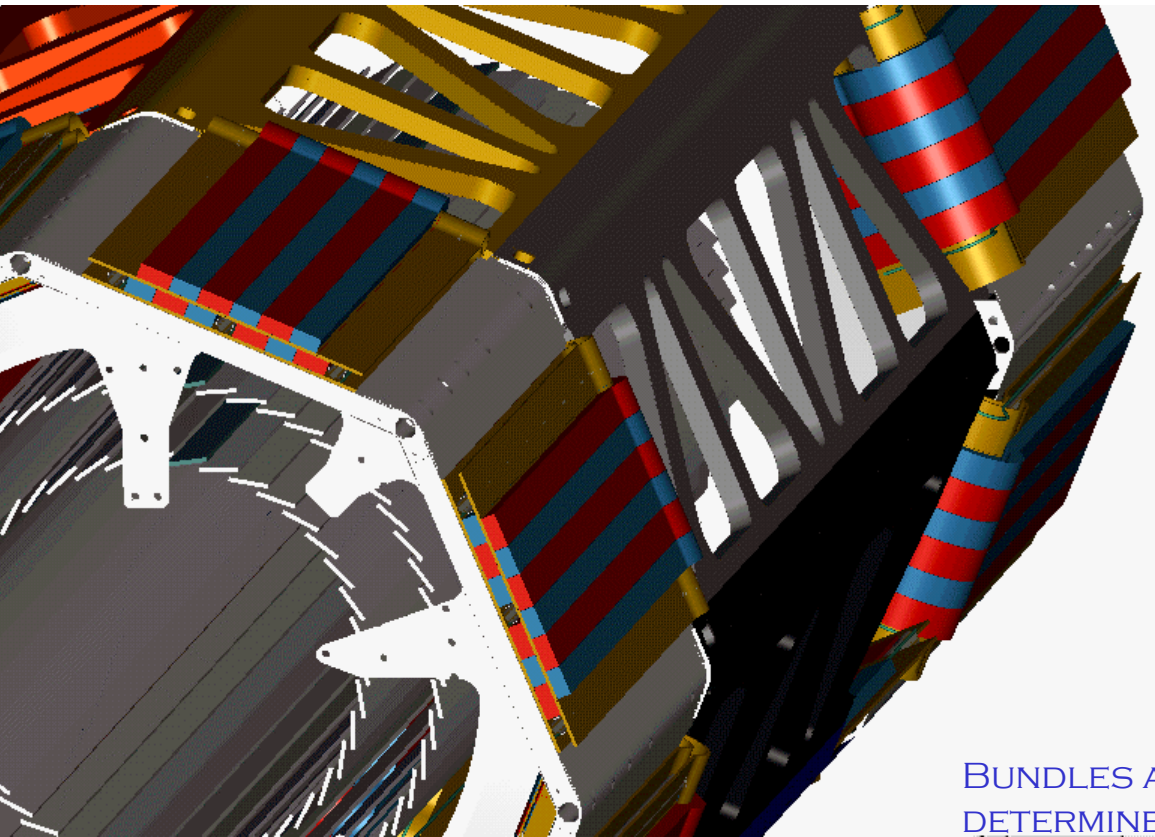
SIDE A



SIDE C

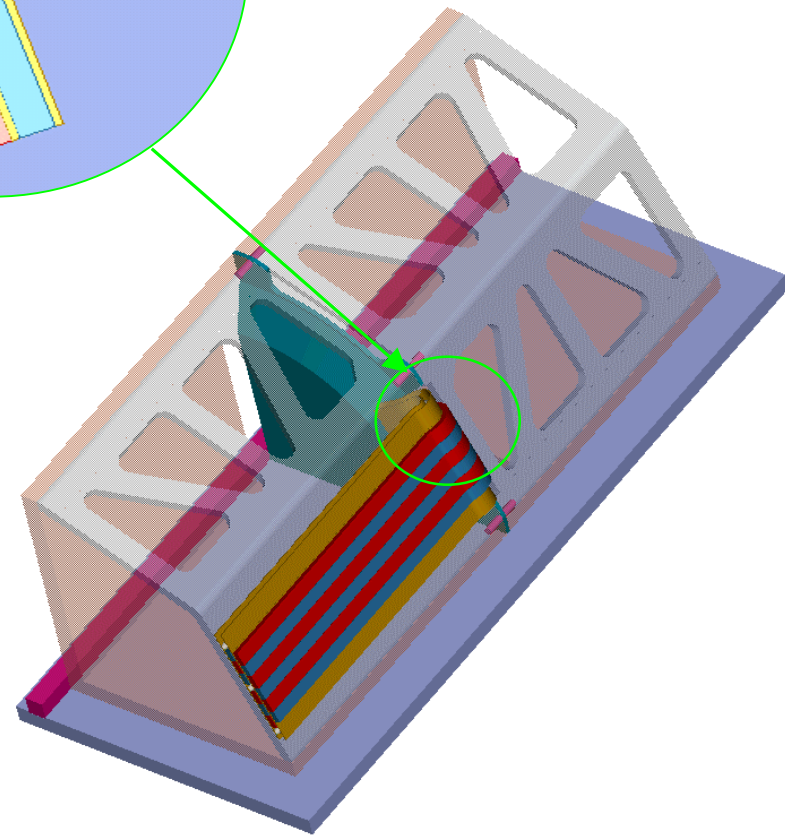
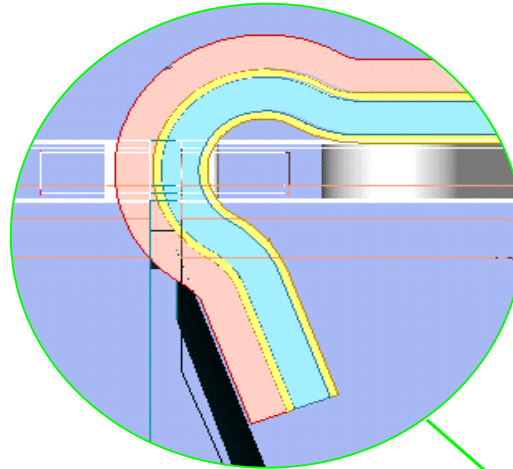
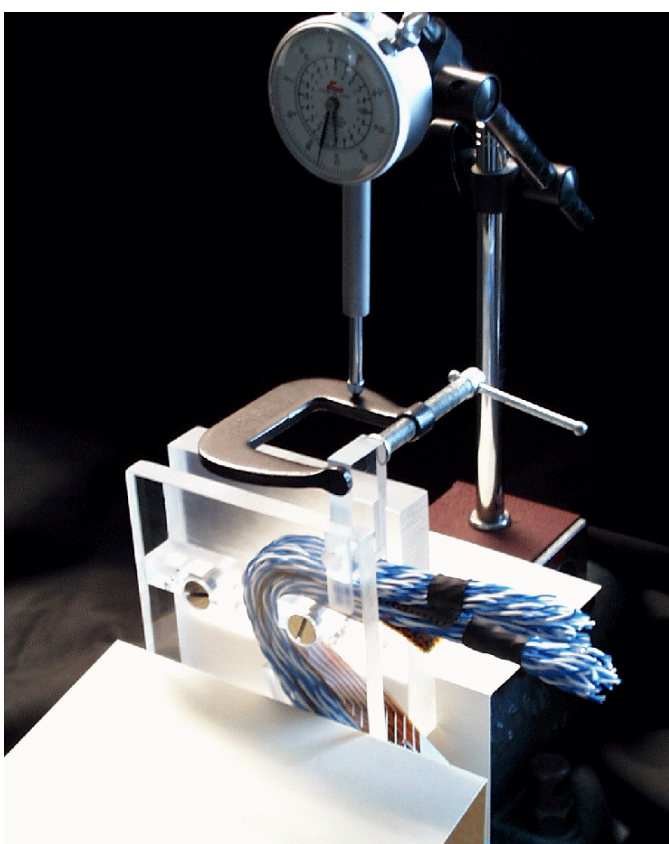


BUNDLES



BUNDLE END VIEW
MONOPHASE

BUNDLES AND ROUTING PRIMARILY DONE TO
DETERMINE MAGNITUDE OF FRAME PENETRATION
NEXT STEPS ARE TO MATCH SERVICES FROM
BARREL AND MAKE BEND AT END OF FRAME

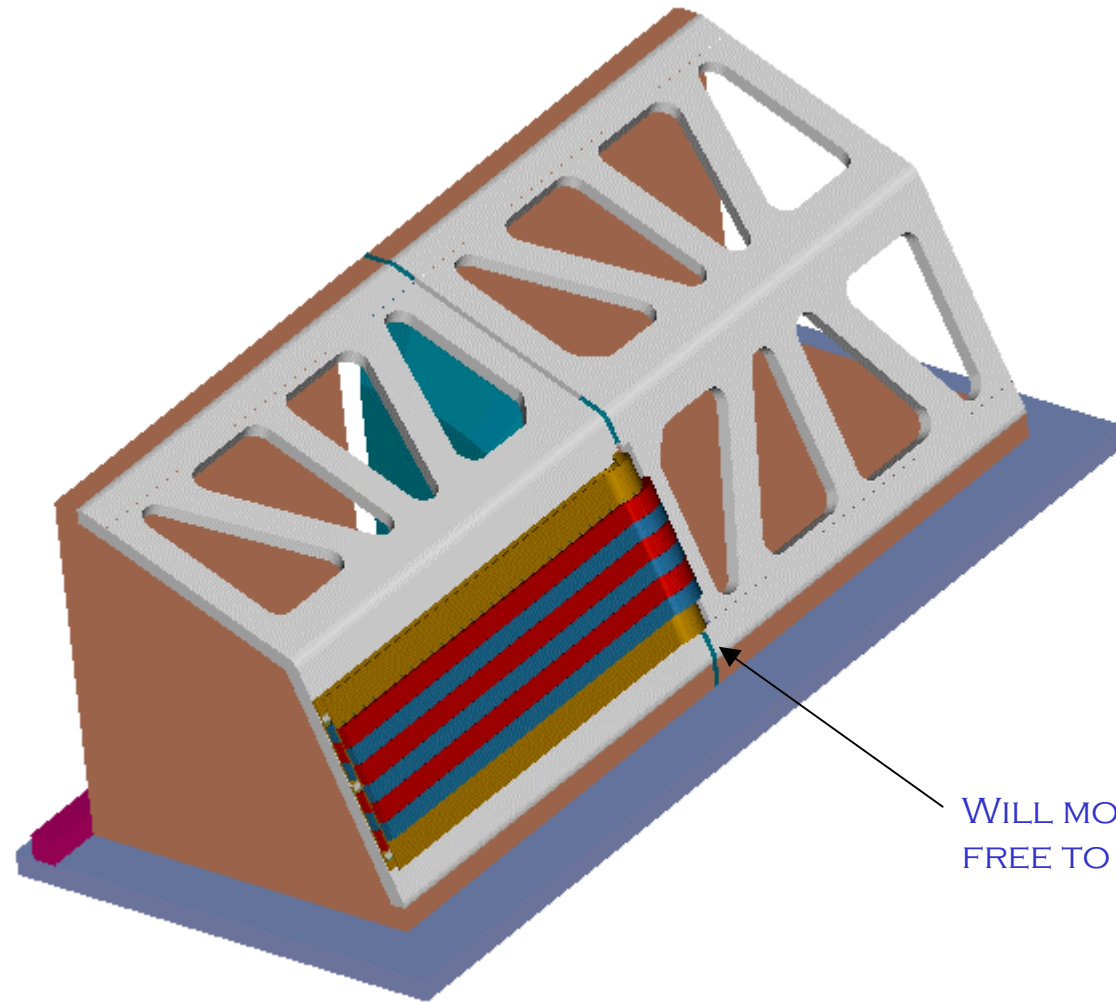


MODEL OF SERVICE BUNDLE CROSS SECTION

- VERIFIED PACKING FACTOR AND BEND RADII
- APPROXIMATELY 20% SAFETY MARGIN
- MEASURED FORCE-NOMINALLY 600GRAMF PER PENETRATION

PIXEL DETECTOR

END FRAME MODEL



- **WILL BUILD 1 / 4 MODEL IN TIME FOR APRIL MEETING**
- **HOPE TO HAVE 2 LAYOUT ITERATIONS BY THEN**
- **PARTS FOR MODEL ARE MADE-NEED ASSEMBLY**
- **MODEL DESIGN ALLOWS FOR EASY REPLACEMENT OF CONE**

WILL MODEL ONE OCTANT FIRST LEAVING SECOND FREE TO MODIFY DIFFERENTLY FOR NEXT ITERATION

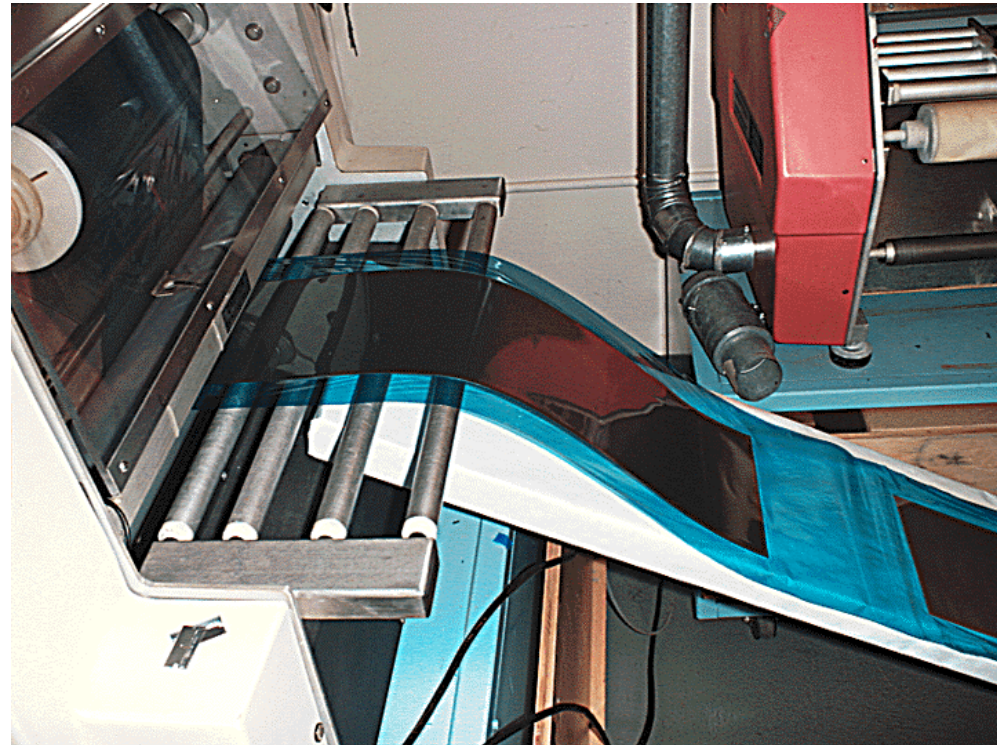
- **HAVE HAD GOOD SUCCESS WITH FABRICATION OF PROTOTYPE CABLES**
- **CURRENTLY FABRICATING FULL LENGTH CU-KAPTON FLEX CABLE PROTOTYPES**
- **SELECTION OF MATERIAL AND PROCESS TO ALLEVIATE LABOR AND COST**
 - PHOTO-IMAGEABLE, ROLL LAMINATED COVERLAY AVAILABLE AND SEEMS TO WORK WELL, NEED TO TEST IRRADIATE
 - GOOD EXPOSURE UNIFORMITY YIELDS SMALLER NEED FOR INSPECTION/TOUCHUP
- **PRESENTLY DOCUMENTING PROCESS AND LABOR TO ASSESS COST BETTER**
- **ELECTRICAL PROTOTYPES COULD BE AVAILABLE BY END OF MARCH (TYPES 1 AND 2)**
 - NEED TO UNDERSTAND TEST NEEDS TO BETTER GAUGE SCHEDULE

PIXEL DETECTOR CABLE PROCESS



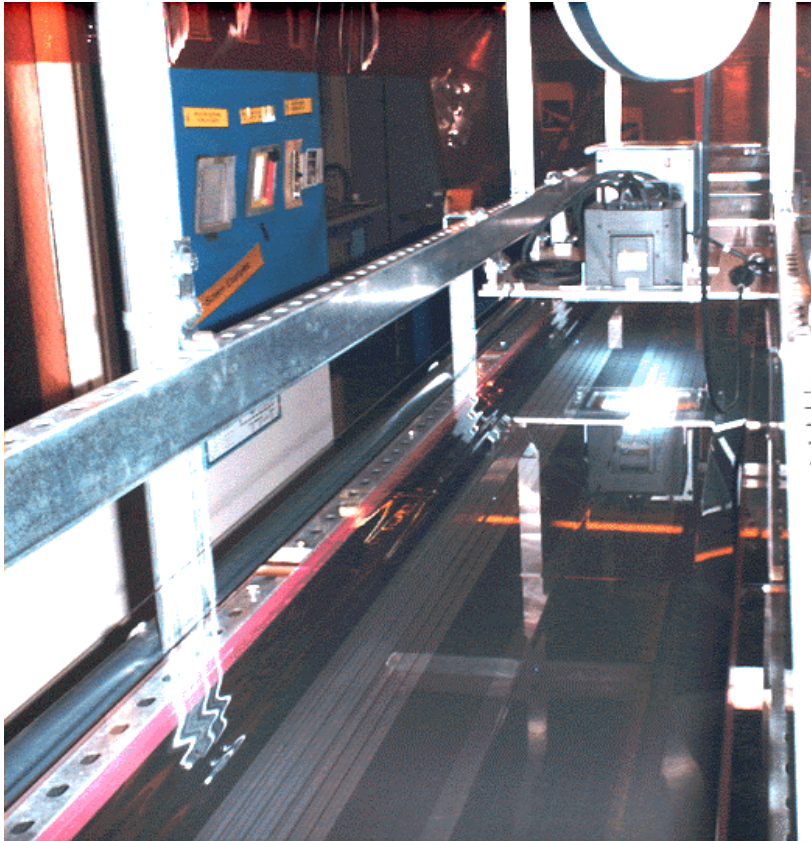
HANDLING EQUIPMENT IS SIMPLE, BUT EFFECTIVE

ROLL LAMINATION PROCESS IS USED TO APPLY
PHOTO-RESIST AND PHOTO-IMAGEABLE COVERLAY



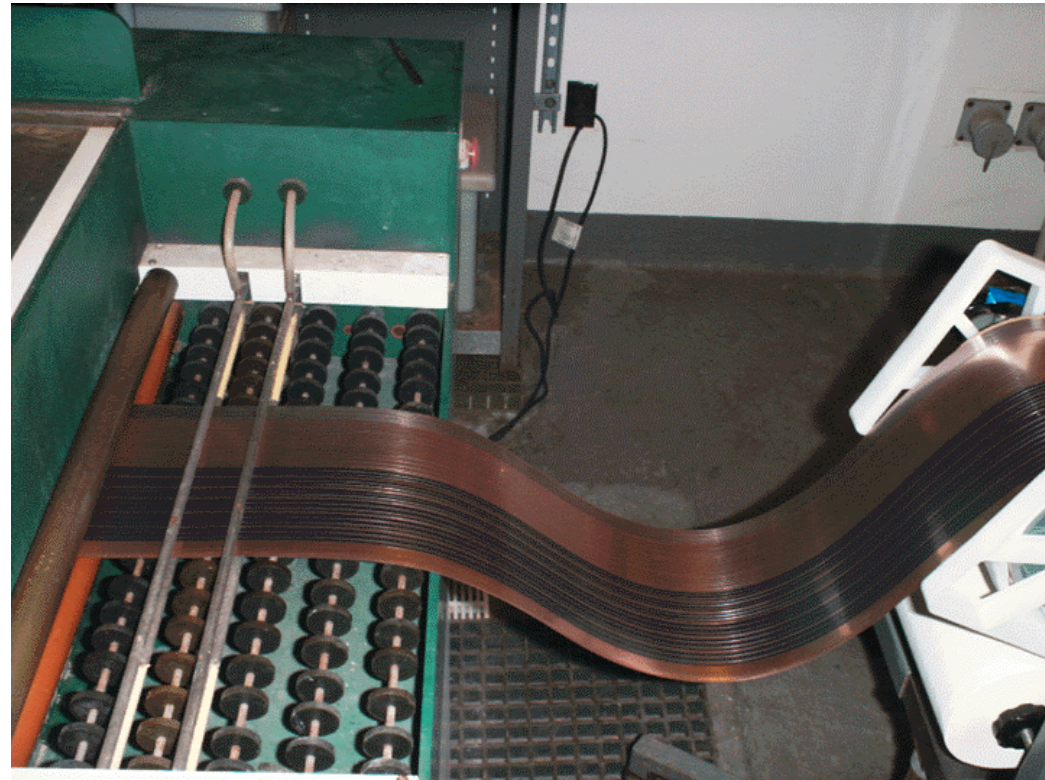
PIXEL DETECTOR

EXPOSE AND DEVELOP



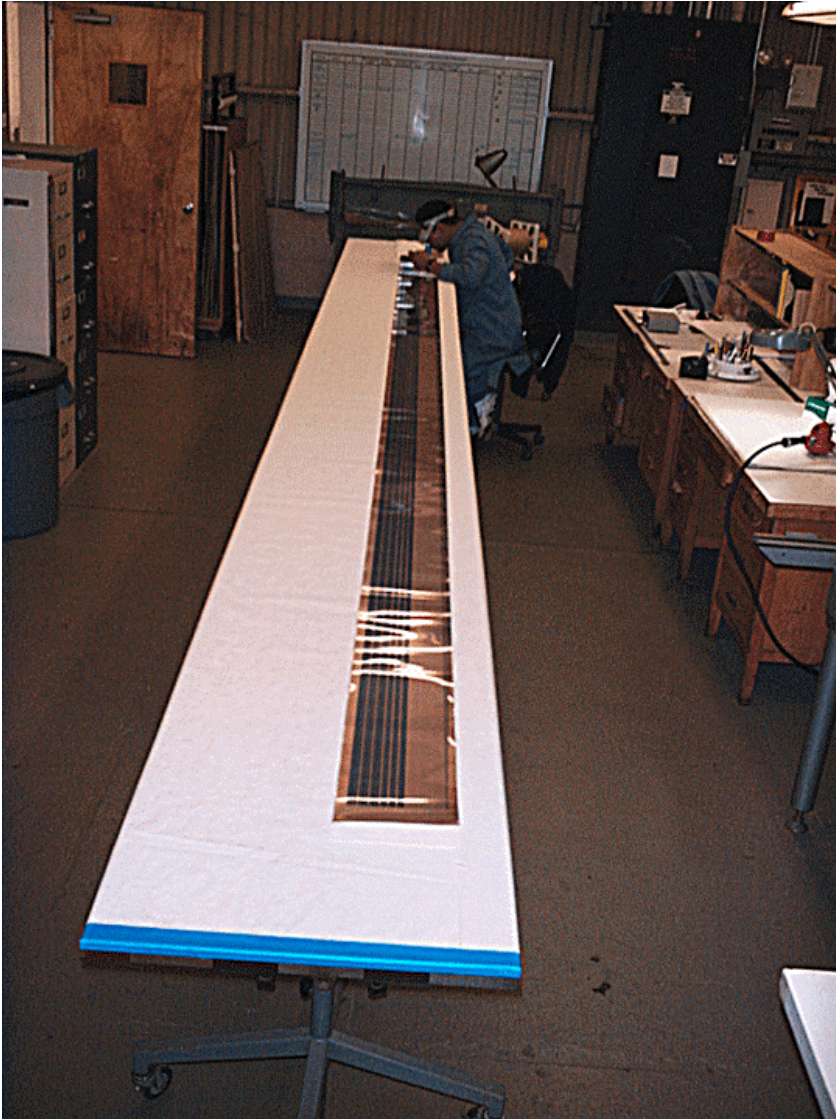
UV EXPOSURE LAMP ON TROLLEY EXPOSES FULL LENGTH OF ARTWORK. LAMINATED CU-KAPTON IS HELD BETWEEN ART LAYERS UNDER VACUUM

CONTINUOUS FEED DEVELOPER REMOVES PHOTO-RESIST THAT IS NOT EXPOSED. ETCHING BATH IS IN A SIMILAR MACHINE. SAME ROLLS ARE USED TO HANDLE MATERIAL AT EACH STEP



PIXEL DETECTOR

TOUCH-UP



- TOUCH UP IS THE MOST LABOR AND SPACE INTENSIVE EFFORT FOR FLEX
- TOUCH UP OF DEVELOPED ART IS NECESSARY TO IMPROVE YIELD
- LAMINATE/EXPOSE/DEVELOP PROCESSES NEED TO BE TUNED TO MINIMIZE TOUCHUP
- TOUCH UP IS POTENTIAL BLACK HOLE FOR MANPOWER

PIXEL DETECTOR

CONCLUSION

- **SERVICE LAYOUT PROCEEDING FULL SPEED AHEAD**
- **NEXT STEP IS TO LOOK AT END OF PIXEL FRAME**
- **PHYSICAL MODELING OF SERVICES COMING ALONG, SO FAR GOOD CORRELATION OF CAD WITH REALITY**
- **EVENTUALLY WILL HAVE TO DROP ONE OF THE COOLING SYSTEMS FROM THE CAD MODELING EFFORT—THIS IS DOUBLING THE AMOUNT OF WORK.**
- **DO NOT FORESEE MOCKING UP BOTH—WILL PROCEED WITH EVAPORATIVE AS BASELINE LACKING DECISION OTHERWISE**
- **ELECTRICAL PROTOTYPES PRESENTLY DE-PRIORITIZED TO MECHANICS EFFORT—CAN CHANGE THIS, BUT NEED REASON TO**